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Racial Diversity and School Performance: A School Location Approach

Simone Angioloni and Glenn C. W. Ames

Department of Agricultural and Applied Economics, The University of Georgia, USA

Abstract: This study investigates the relationships among racial diversity, school performance, and school location. Through spatial regression techniques, we find evidence of a positive relationship between achievement score and racial diversity for the fourth grade students in Georgia's public schools. Direct effects, as defined by the spatial Durbin error model, are stronger in urban schools which are at the lowest levels of racial diversity. In contrast, indirect effects are present at the highest levels of racial diversity, namely in suburban and town schools.

Keywords: educational achievement, racial inequality, school location

JEL Codes: C31, I240, R5

1. INTRODUCTION

Sixty years after the 1954 U. S. Supreme Court decision in Brown v. Board of Education, a substantial amount of debate on racial diversity and school performance has involved parents, educators, policy makers, and researchers (Armor, 1996). Despite this, uncertainty still remains regarding the ultimate effect of racial diversity on educational achievement.

In general, a positive relationship between racial diversity and achievement score can be due to racial peer-effects (Hoxby, 2000). Racial peer-effects mean that low achieving peers gain more by being exposed to high achieving peers than high achieving peers lose by being exposed to underperforming peers. If this asymmetry is strong, then investments in human capital are maximized when students attend schools with a broad array of abilities and backgrounds. Within the U.S., several studies have highlighted how racial peer-effects improve students' school performance. Hoxby (2000) shows that having a larger share of Asian students in class increases Hispanic students' performance in mathematics from the third grade to the fifth grade. Similarly, Hanushek, Kain, and Rivkin (2009) determined that African-American students' academic achievement is lower when they are exposed to a higher percentage of nonwhite classmates.

In contrast, a negative relationship between racial diversity and achievement scores can be due to underprovision of educational resources. Alesina, Baqir, and Easterly (1999) indicate that racial groups often have different views on the optimal provision of public goods. Racial groups whose preferences are not represented by the school policy might vote to reduce public spending on education since this will cut funding for programs of which they do not approve. The authors provide evidence that regions with high levels of racial diversity are characterized

Angioloni is a Researcher in agricultural and applied economics at the University of Georgia, Athens, GA. Ames is Emeritus Professor of agricultural and applied economics at the University of Georgia, Athens, GA. *Corresponding Author:* S. Angioloni E-mail: sangiol@uga.edu

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by lower public spending on infrastructure and education. Thus, if lower per pupil spending implies lower school performance, the relationship between racial diversity and achievement score could be negative. Recently, Hall and Leeson (2010a) determined that racial fractionalization decreases the educational achievement of ninth grade students by 7 to 17.5 percent in Ohio school districts.

In addition, local spillover effects may be present. Local spillover effects mean that the characteristics of the nearby schools drive students and families to cross school boundaries. For instance, there is evidence that less-able children gain more from peer effects than more-able children lose (Summers and Wolfe, 1977; Hoxby, 2000; McEwan, 2003). There is also evidence that white and Asian students perform higher, on average, than other racial groups at the national level and in Georgia in particular (The Nation's Report Card, 2013). If this is the case, racially segregated families might have a higher willingness-to-pay to move to a neighborhood with a school that has more-able students. In other words, the school's racial diversity can create an externality on the adjacent communities, affect the mobility patterns across school borders and, thus, generate local spillover effects (de Bartolome, 1990; LeSage, 2014).

Consequently, the goal of this study is to empirically investigate the relationships among racial diversity, school performance, and school location. This study uses school-level data on race and educational achievement for public-school fourth graders in Georgia for the 2011-2012 academic year. This study employs school-level data for four reasons. First, the state's accountability system allocates rewards and/or sanctions to schools on the basis of aggregate student performance on standardized tests (Figlio and Loeb, 2011). Second, school-level data are used by families to make informed decision about their school options (Sjord, Visscher, and De Jong, 2001; Hastings, Kane, and Staiger, 2005). Third, school performance may affect other economic and educational aspects such as the housing market and private donations in support of educational programs (Lareau and Goyette, 2014). Fourth, there are theoretical and empirical reasons to assume that spatial spillover effects are present at the school level, as this paper will show.

The paper is organized as follows: Section 1 introduces the issues and the related topics; Section 2 provides the institutional background; Section 3 describes the microeconomic model; Section 4 introduces the dataset and the variables employed; Section 5 presents the empirical strategy and econometric approach; Section 6 presents the results; while conclusions are drawn in Section 7.

2. LOCAL SPILLOVER EFFECTS AND STUDENT MOBILITY IN GEORGIA PUBLIC SCHOOLS

A local spillover effect can be present when a family/student selects the locality/school that maximizes its utility considering the characteristics of the other schools. In this case, school characteristics can affect student mobility and thus generate local spillover effects. In particular, a spatial local spillover effect is present when the k^{th} characteristic/independent variable X_j^k of the j^{th} school located at position j affects the achievement score, y_i, of the i^{th} school located at position i (LeSage, 2014). In other words, the cross-partial derivatives or indirect effects $\partial y_i / X_j^k$ are different from zero.

In general, the proximity of the parents' or legal guardians' residences to the school determinates the student's assignment (Governor's Office of Student Achievement, 2014). But students may attend a different school during the academic year. In the 2012-2013 school year, six percent of the student population transferred into another public school in Georgia. Among them, 40 percent moved to another school in the same district (intra-district school transfer) while 60 percent moved to a different school district (inter-district school transfer). The more mobile students in Georgia are African-American, low-income, or disabled. In contrast, the share of white students was observed to be negatively related to student mobility in Georgia. No significant differences were detected with respect to the other races (Governor's Office of Student Achievement, 2014). The highest incidence of student mobility is observed in urbanized areas such as Atlanta, Augusta, Columbus, Savannah, Macon, and Valdosta.[1] Finally, due to the lack of public support for student transfers, student mobility mostly happens in response to household mobility in Georgia (Education Commission of States, 2015).[2]

Research on racial diversity and achievement score has generally focused on school district level data. For instance, Hall and Leeson (2010a) studied this relationship for ninth grade students in Ohio school districts. Also, recent research on spatial spillover effects and education has considered school districts. Yadavalli, Waldorf, and Florax (2013) find that spending per pupil raises the migration rate in urban districts in the U. S. In contrast, the focus of this paper is on school-level data rather than broader district data. Although racial and economic differences are present between school districts, these differences are more marked at the school level.

First, racially heterogeneous school districts can be characterized by racially segregated schools. In Georgia, the perfect example is given by the Fulton School District. The Fulton School District is the only noncontiguous school district in the state (Fulton County Schools, 2015). The district crosses Atlanta from north to south, but it does not include schools located in the inner city that belong to the Atlanta school system. At the district level, Fulton County is characterized by high racial diversity. The district's racial fractionalization index calculated over five racial groups corresponds to .70 (white, black, Hispanic, Asian, and other) using Hall and Leeson's approach (2010a). But this estimate does not show that schools located in the southern district are mostly African-American (racial fractionalization index smaller than .20) while schools located in the northern district are mostly white (racial fractionalization index smaller than .35). At the district level, what is racially segregated can appear racially integrated.

Second, in the same school district, racially segregated groups can generate conflicts in educational funding issues. In Georgia, the largest share of public funds is collected at the local level. In the 2010-2011 school year, 15 percent, 37 percent, and 48 percent of the kindergarten through twelfth grade (K-12) Georgia school budget was supported by federal, state, and local funds, respectively (National Education Association, 2011). Local funds are collected though property taxes at the school district level and are allocated among schools in the same district (Roza, 2010). Since a student is assigned to a school according to the proximity of the parents' residence, educational policies directed to a specific school can be ostracized by those racial groups that are not represented in that school (Governor's Office of Student Achievement, 2014).

Toppo and Overberg (2014) report the case of a school district in Eden Prairie, Minnesota where the superintendent re-drew the boundaries of the schools to allow for a more equitable

[1] The analysis is at the school district level and it does not allow differentiate urban schools from suburban school (Governor's Office of Student Achievement, 2014).

[2] Although the educational policy in Georgia allows for student transfer, there is no public support of any type for educational mobility (Education Commission of States, 2015).

allocation of resources. A similar case is reported by Taylor (2015) for New York schools. Finally, Hall and Leeson (2010b) highlighted a historical case of funding strife in Cleveland. All these cases are characterized by conflicts between racial communities in the same school district. While these examples are particularly extreme, they indicate that substantial differences are present between schools within the same district. These differences generate preferences between communities that can be expressed through formal channels such as voting and informal channels such as social issues. Moreover, these differences can affect student mobility and thus generate local spillover effects. The next section discusses the microeconomic background of school and racial diversity.

3. MICROECONOMIC BACKGROUND

There are several theoretical models that explain the interactions among location, education, and race. In the following section, we follow de Bartolome (1990) whose model fits the analytical approach in this paper for several reasons. First, de Bartolome's model considers a public educational system at the local level where communities express their preferences on school inputs. Second, the model considers two nearby communities where the mobility patterns are determined by peer effects and school quality. Third, de Bartolome shows how perfectly integrated, mixed, and perfectly segregated communities can be present. Fourth, his model will be useful in interpreting our results. The following part introduces the main points of de Bartolome's model.

Families are located in two communities differentiated on the basis of a unique attribute, the share of high-ability students. One community, for instance in an urban neighborhood, is characterized by a lower share of high-achieving students while the other community, for instance a suburban neighborhood, is characterized by a larger incidence of high-achieving students. The size of the population in each community is fixed. Without loss of generality, the model assumes that families in the two communities are endowed with the same fixed income. In de Bartolome's model, this assumption is later relaxed, but it is useful to show how mobility patterns shape the (racial) composition of the two communities regardless of income. Similarly, the housing stock is fixed and all houses are equivalent.

The educational system is such that all the families in the same community attend the same school and receive the same amount of educational inputs. Educational inputs represent the per capita monetary value of the quality of the school given by several factors, such as per pupil spending, years of experience of the teaching body, and the student/teacher ratio. These inputs are financed by local taxes in each community. A family chooses the input level that maximizes its utility ignoring the possible effects of its choice on the community. Finally, each family pays a rent differentiated by community. Thus, the family/student problem is to maximize its utility function with respect to the student's achievement score, y, and consumption, C, after rent, r, and the educational inputs, I, have been paid:

$$\max_{C_j, I_j} U\left[C_j; y\left(I_j, \theta_j\right)\right] \tag{1}$$

$$C_j = income - r_j - I_j \tag{2}$$

where the suffix j stands for urban/suburban location. The student's achievement score, y, is a function that depends on the level of educational inputs, I (input effects), and the proportion, θ, of more able children in the community (peer group effects). Regularity conditions on the first and the second derivatives are also assumed. Moreover, the model assumes that input and peer effects follow a specific pattern:

(3) $$\frac{\partial y(I,\theta)^{low}}{\partial I} < \frac{\partial y(I,\theta)^{high}}{\partial I}$$

(4) $$\frac{\partial y(I,\theta)^{low}}{\partial \theta} \geq \frac{\partial y(I,\theta)^{high}}{\partial \theta}$$

Inequalities (3) and (4) indicate that a more able child is assumed to gain more from educational inputs while a less-able child is assumed to gain as much from peer-effects. The presence of these inequalities is confirmed by several studies on educational spillover effects in education (Summers and Wolfe, 1977; Hoxby, 2000; McEwan, 2003).

Community compositions and rent are determined through mobility. A family evaluates each community, taking the school quality, the associated tax, the housing rent, and the peer group as given, and moves into the community that gives the highest utility. Community compositions and house rents adjust until no family can obtain a higher utility by moving. One fundamental point of de Bartolome's model is that inequality (4) represents an integrating force since it pushes low-ability families to move from a community with a small proportion of high-ability children (urban) to a community with a large share of high-ability students (suburbs). In other words, low-ability families exhibit a higher willingness-to-pay for peer effects than high-ability families. In contrast, inequality (3) is a segregation force that stimulates high-ability students to move from the urban community to a suburban community. Which of these two forces will be prevalent determinates, together with the initial composition of the population, the final equilibrium.

Intuitively, if peer effects are strong enough with respect to the input effects, the equilibrium will produce two identical communities composed of the same share of high/low-ability students. Conversely, if input effects overwhelm peer-effects, the solution will be segregation where at least one community is composed of only one ability group. In any case, the maximum efficiency (second-best) is reached by perfectly integrated communities. In other words, racial diversity increases social welfare, but it can require the social planner's action.[3] In summary, although other theoretical models show that integration represents a stable and efficient equilibrium (Becker and Murphy, 2000), predictions crucially depend on the model assumptions and the context (Bénabou, 1993; Epple, Romano, and Sieg, 2003). The next section introduces the data and their description.

4. DATA

4.1 Data Source and Variable Definitions

The school-level variables are collected from three sources: the Georgia Department of Education (2015a; 2015b), the Governor's Office of Student Achievement (2015), and the National Center for Education Statistics (NCES, 2015). The dataset covers the 2011-2012 academic year. Only public-school fourth-grade classes that were not restructured, transformed, or otherwise substantially changed as a consequence of the state's accountability system were considered (NCES, 2015). Special educational programs such as magnet, charter, vocational, and

[3] Actually, there is a solution that achieves perfect integration and thus the maximum (second-best) efficiency in de Bartolome's model. This solution is feasible only for particular initial conditions of the student population, and it was not considered since perfect integration is not common in real-life situations.

shared-time schools were also not included because they represent an alternative educational model (Bifulco and Ladd, 2007; Magnet Schools of America, 2012; Patrick, 2015).[4]

The school performance data are achievement scores in mathematics and reading for fourth-grade students in Georgia. The achievement score is the share of students who met or exceed the standard of the Criterion Reference Competence Test (CRCT) in each school. The threshold of the CRCT is set at the state level in Georgia (Georgia Department of Education, 2015a).

The racial variables are collected from the Public Elementary/Secondary Universe Survey Data by the National Center for Education Statistics (2015). Seven racial groups are considered in the survey: American Indian/Alaska native, Asian, Hispanic, black non-Hispanic, white, Hawaiian native/Pacific Islander, and persons of two or more races. Following Hall and Leeson (2010a), the racial fractionalization index measures the probability that two randomly drawn individuals from the overall population belong to different ethnic groups:

$$rf_j = 1 - \sum_{k=1}^{K} \pi_{jk}^2 \quad (5)$$

Where π_{jk} is the share of the racial group k in school j. The index is bounded by zero and one and increases with racial diversity. The number of racial groups employed in this study is five: African-American, Asian, Hispanic, white, and all other races.

The poverty rate is the share of students, per school, who are eligible to participate in the free or reduced-price lunch program under the National School Lunch Act (NCES, 2015). Eligibility is based on family income: children from families with incomes at or below 130 percent of the poverty level are eligible for free meals. Children with incomes between 130 percent and 185 percent of the poverty level are eligible for reduced-price meals (U.S. Department of Agriculture, Economic Research Service, 2014).

The data on the institutional characteristics of schools are collected by the Governor’s Office of Student Achievement (2015a). These include the student/teacher ratio and the average years of teachers’ experience. The student/teacher ratio and the average years of teachers’ experience are based on full-time equivalent measures. Full-time equivalent represents the workload of an individual (student, teacher, and staff member) comparable across schools (Georgia Department of Education 2014a). The Governor’s Office of Student Achievement (2015) also provides information on the annual spending per full-time equivalent student. All monetary values are in real dollars based on the consumer price index for the Atlanta-Georgia region, base year 2011 (Bureau of Labor Statistics, 2015).

The data on the socio-economic characteristics of the school are collected from U.S. Census Bureau’s 2009-2013 Five-Year American Community Survey (2015) at the census tract level for the year 2011. In Georgia, there is a nearly one to one correspondence between elementary public schools and census tracts. In the school year 2011-2012, there were 1,149 elementary public schools for 952 census tracts (U.S. Census Bureau, 2015b). In this paper, the variables considered at the census-tract level are human capital factors such as the percent of single parent families and the share of adult population with a high school degree or higher.

[4] In the school year 2011-2012, special educational programs involved less than six percent of the elementary public schools in Georgia (NCES, 2015).

Also, the share of households with limited English proficiency and the unemployment rate are included to control for the socio-economic status of the school neighborhood.

The data on the spatial location are collected from National Center for Education Statistics (NCES, 2015) through the Common Core of Data (CCD). The CCD is a national statistical program that collects administrative data from state education agencies (SEAs) covering the universe of all public elementary and secondary schools in the U.S. The CCD provides the coordinates of the school building and the NCES classifies them with respect to school location. Location categories are derived from urban and rural classifications and principal city definitions as determined by the U.S. Census Bureau. The NCES (2015) classifies schools in four principal categories: urban, suburban, town, and rural. A similar classification was employed by Ruggerio (2001) in an analysis of the efficiency of the public spending. The descriptive statistics are presented in Table 1 while Appendix Tables 1 and 2 report the exact definition of each variable.

4.2 Data Description

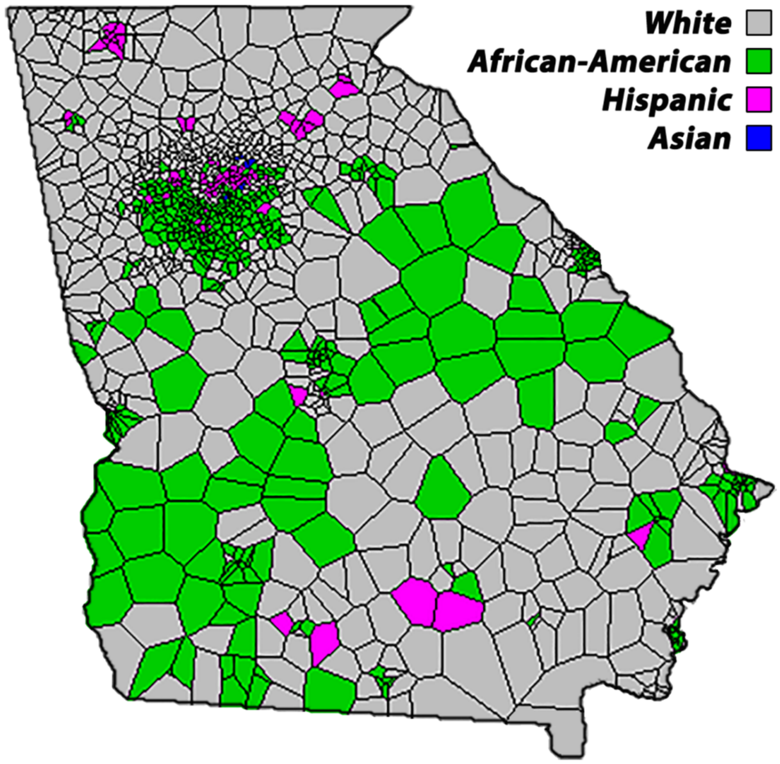
Figure 1 and Figure 2 show the spatial distribution of public elementary schools in Georgia according to their racial majority group and location. The polygonal cells represent the

Table 1: Descriptive Statistics on Georgia's Fourth Grade Public Schools

	Average	Standard Deviation	Variable Level
Mathematics (%)[1]	0.78	0.15	School
Reading (%)[1]	0.89	0.09	School
Poverty Rate (%)[2]	0.66	0.25	School
Student Teacher Ratio[3]	0.15	0.02	School
Teaching Experience[4]	0.14	0.02	School
Per Pupil Spending (real dollars)[5]	$9,061	$1,354	School
Racial Fractionalization Index	0.45	0.21	School
Unemployment Rate (%)	0.07	0.03	Census Tract
Limited English Speaking Household (%)[6]	0.03	0.05	Census Tract
Single Parent Families (%)	0.37	0.21	Census Tract
Population With High School Degree or Higher (%)	0.83	0.10	Census Tract
Urban (= 1 if school located in a city)[7]	0.19	0.39	School
Suburban (= 1 if school located in a suburban area)[7]	0.35	0.48	School
Town (= 1 if school located in a town)[7]	0.09	0.28	School
Rural (= 1 if school located in a rural area)[7]	0.37	0.48	School
Number of Observations (schools)[7]	1,149		

[1] Share of students who passed the fifth grade math and reading exam on the annual CRCT.
[2] Share of students per school who are eligible for reduced price or free meals (NSLP).
[3] Full-time equivalent students divided by full-time equivalent teachers.
[4] Average years of experience of PK-12 teachers in the school.
[5] Adjusted with the Consumer Price Index for the Atlanta-Georgia area, 2011 base year.
[6] No one age 14 and over speaks English "very well".
[7] For the geographical classification, see Appendix Tables 1 and 2.

Figure 1: Public Elementary Schools in Georgia by Racial Majority Group



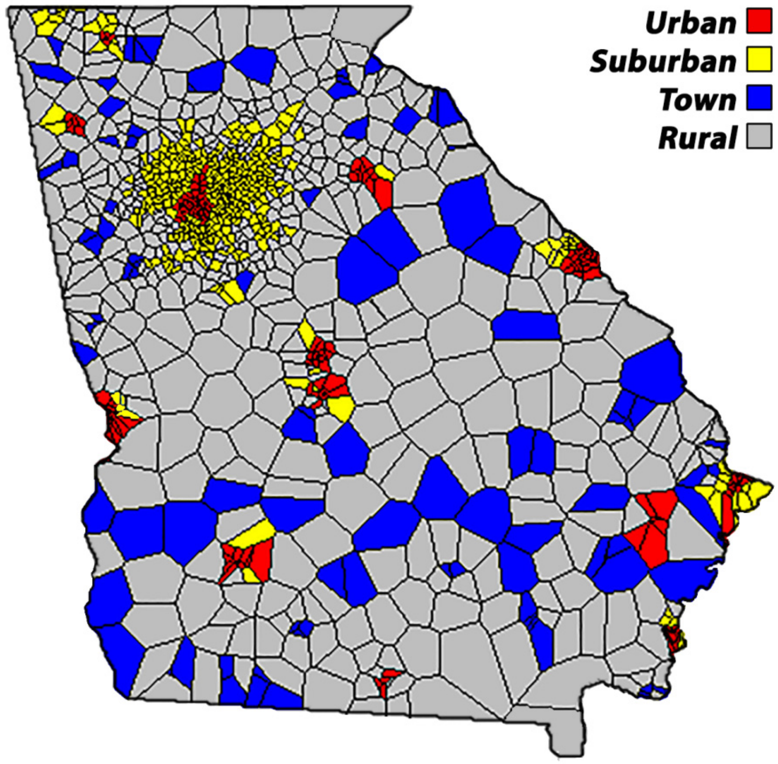
The figure shows the Voronoi tessellation of the fourth grade public elementary schools in Georgia. The Voronoi tessellation was realized on a rectangular window defined over the boundaries of Georgia. The rectangular window was deleted to make the map clearer. Each cell corresponds to a school and was coded according to the majority racial group in that school.

school attendance areas and were estimated with the Voronoi diagram (see Section 5.2). Each cell was then identified according to their racial majority group (Figure 1) and location (Figure 2).

In the 2011-2012 school year, 52 percent of the Georgia elementary public schools were white majority, 40 percent African-American majority, 7 percent Hispanic majority, and 1 percent Asian majority. Figures 1 and 2 indicate that white majority schools are distributed in the northern part of Georgia and in particular in the northern suburbs of the Atlanta Metropolitan Area (AMA, U. S. Office of Management and Budget, 2013). A substantial presence of white majority schools is also found in rural areas. Interestingly, only one public elementary school in Georgia in the 2011-2012 school year, the Ephesus Elementary school in the rural Heard County, was observed as completely white. It was characterized by a relatively low poverty rate (55 percent) and high achievement scores: 88 percent and 94 percent in reading and mathematics, respectively.

African-American majority schools are mostly distributed in urban and suburban areas and in particular in the southern part of the Atlanta Metropolitan Area. In addition, a consistent part of African-American majority schools is distributed over the Black Belt. The Black Belt is a region of the southern U.S. that crosses Georgia in the middle along the North-East, South-West diagonal (for a review of the socio-economic characteristics of the Black Belt see Webster and

Figure 2: Public Elementary Schools in Georgia by Location



The figure shows the Voronoi tessellation of the fourth grade public elementary schools in Georgia. The Voronoi tessellation was realized on a rectangular window defined over the boundaries of Georgia. The rectangular window was deleted to make the map clearer. Each cell corresponds to a school and was coded according to its location.

Bowman, 2008). Several completely homogeneous African-American schools were observed in these areas.

Hispanic majority schools are also located in urban and suburban areas, but in particular in north Georgia. In general, no completely homogeneous Hispanic schools were observed. In addition, Hispanic schools were characterized, on average, by better achievement scores than Africa-American schools, but less than white and Asian schools.

In the 2011-2012 school year, only six schools were observed to be Asian majority, five located in the suburban areas and one in a rural area. Asian majority schools are characterized by very high achievement scores and very low poverty rates. The only exception is the Indian Creek Elementary school in DeKalb County. The Indian Creek Elementary schools, classified as suburban, was observed with achievement scores equal to 56 percent and 37 percent in reading and mathematics, respectively, and with poverty rates equal to 100 percent. This school is also characterized by substantial racial diversity. The school's website highlights the socio-economic environment as one where "students come from more than 40 countries around the world…many have arrived as refugees from countries experiencing war and political unrest" (Indian Creek Elementary School, 2015).

Table 2 shows additional analysis on the relationship between race, school performance, and school location in Georgia. As expected, the urban schools have the lowest achievement score

Table 2: Descriptive Statistics on Georgia's Fourth Grade Public Schools by School Location

	School Location (average per school location)			
	Urban[1]	Suburban[1]	Town[1]	Rural[1]
Reading Score (%)[2]	0.81	0.90	0.89	0.91
Mathematics (%)[2]	0.65	0.80	0.80	0.82
Poverty Rate (%)[3]	0.81	0.62	0.70	0.61
Racial Fractionalization Index (%)[4]	0.31	0.47	0.50	0.41
White Student (%)	0.16	0.32	0.49	0.62
African-American Student (%)	0.71	0.40	0.37	0.24
Hispanic Student (%)	0.09	0.19	0.10	0.09
Asian Student (%)	0.01	0.06	0.01	0.02

[1] For the geographical classification, see Appendix Tables 1 and 2.
[2] Share of students who passed the fifth grade math and reading exam on the annual CRCT.
[3] Share of students per school who are eligible for reduced price or free meals (NSLP).
[4] Calculated as in equation (5).

regardless of the subject matter. Moreover, the poverty rate is higher in urban schools and lower in suburban, town, and rural institutions.

In addition, Table 2 indicates that the racial fractionalization index achieves, on average, a minimum in urban schools, then it increases in suburban and town schools, and finally it decreases in schools located in rural areas. This pattern is substantially explained by the shares of white students and African-American students. The white student share is .16 in urban schools, .32 in suburban schools, .49 in town schools, and .62 in rural schools. The African-American share shows an opposite pattern steadily decreasing as we move from urban schools to rural schools. These data suggest that the Georgia public schools are characterized by two extremes: predominately African-American, low-performing, low-income schools located in urbanized areas and predominately white, high-performing, high-income schools located in rural areas. Moving from one extreme to the other, there are intermediate changes given by suburban schools and town schools. The next section introduces the econometric approach employed to test direct and indirect effects with respect to the school location.

5. EMPIRICAL STRATEGY AND ESTIMATION APPROACH

5.1 Empirical strategy

There are two central issues in estimating the relationship among racial diversity, educational achievement, and school location. First, the direct effect of racial diversity on the achievement score should be maximized in urban schools. In these schools, it is reasonable to consider that an increase of racial diversity will be associated with the largest increase in the achievement score either because of nonlinearity of peer effects as shown by inequality (4) or because higher racial diversity simply means larger presence of high-ability students. If this is true, direct effects of racial diversity on the achievement score should be maximized for low levels of racial diversity.

In contrast, the indirect effects can be maximized at the highest levels of racial diversity. In suburban and town schools, there are more high achieving students with respect to urban schools as shown by Table 2. In addition, suburban and town schools are characterized by a lower poverty level than urban schools in Georgia. Less-binding socio-economic conditions and more variability can stimulate student and household mobility in suburban and town schools. This fact is confirmed by other studies that indicate how student mobility of more-affluent families is characterized by a longer range involving schools located in different districts (Eadie et al., 2013). Conversely, Georgia's rural schools may have enough high-ability students and affluent families, but a limited number of potentially mobile families, and the reduced racial differences might mitigate the indirect effects. In other words, if ability groups can be represented by racial groups, indirect effects may be maximized at the highest levels of racial diversity, namely suburban and town schools.

These hypotheses can be tested through interaction terms between the index of racial fractionalization and binary variables (slope shifters). These binary variables will be defined with respect to school location (urban, suburban, town, and rural) and the interaction terms will indicate if the supposed direct and indirect effects depend on school location. Then, this procedure will be repeated with binary variables defined over the quartiles of the racial fractionalization index. This way, we will be able to test if direct and indirect effects change with respect to the magnitude of the racial fractionalization index. We call the estimates without the slope shifters the *baseline model* and the estimates with the slope shifters the *extended model*. Note that intercept shifters were also considered in the extended models to catch the differences in the achievement scores as shown by Table 2.

The second empirical problem is that the relationship between racial diversity and achievement score could be endogenous (Hoxby, 2000). Parents can choose which school their children attend on the basis of different factors, primarily related to the school performance (Reback, 2008; Georgia Public Policy Foundation, 2010). In particular, household mobility may happen in response to educational achievement (Lareau and Goyette, 2014). This problem is more serious considering that the school reports provide data on the achievement scores in reading and mathematics, the dependent variables used in this analysis, which allow parents to make informed decisions on their school options (Georgia Public Policy Foundation, 2010).

In addition, endogeneity could be due to simultaneity. If low-performance schools discourage the academic engagement of higher-performing racial groups, then racial fractionalization could decrease. In general, student disengagement can be caused by poor quality of instructional resources and low expectations (Trout, 1997). If the instructional activity is not intellectually challenging, students might reduce their academic engagement and eventually drop out of school. Gillborn and Kirton (2010) find that white students underperform non-white students in low-income schools. Given the potential endogeneity of racial diversity, it will be necessary to test if this is the case and eventually employ specific estimation techniques (Anselin and Bera, 1998; Monchuk et al., 2011).

5.2 Estimation Approach

A spatial regression model is developed to estimate the relationship between achievement score and racial diversity. Following LeSage (2014), we consider two local spillover specifications, the spatial Durbin error model (SDEM) and the spatial lag of X model (SLX). If y is the achievement score, the SDEM model is defined as:

(6) $$\boldsymbol{y} = \boldsymbol{X\beta_1} + \boldsymbol{WX\beta_2} + \boldsymbol{\varepsilon}\,;\, \boldsymbol{\varepsilon} = \lambda \boldsymbol{W\varepsilon} + \boldsymbol{u}$$

where $\boldsymbol{X}$ is a matrix of covariates, $\boldsymbol{W}$ is a weight matrix, and $\boldsymbol{u}$ is assumed to be i.i.d. If $\lambda = 0$, the model becomes the SLX model:

(7) $$\boldsymbol{y} = \boldsymbol{X\beta_1} + \boldsymbol{WX\beta_2} + \boldsymbol{\varepsilon}$$

where, in this case, $\boldsymbol{\varepsilon}$ is assumed to be i.i.d. In equation (6) and equation (7), the vector of coefficients $\boldsymbol{\beta_1}$ represent the direct effect of each covariate on the dependent variable, the achievement score. With row-standardized weight matrices, the vector $\boldsymbol{\beta_2}$ also represents the cumulative effect of the cross-partial derivatives on the dependent variable (LeSage, 2014).

The construction of the weight matrix, $\boldsymbol{W}$, is based on the Voronoi diagram, also called Voronoi tessellation or Thiessen polygons (Okabe et al., 2000). The Voronoi diagram is a geometrical technique that employs the perpendicular bisector method to solve the closest-point problem. The Voronoi diagram was realized on a rectangular window defined over the boundaries of Georgia. A binary contiguity matrix, which is row-standardized, was considered. Two schools are defined as neighbors if they share a common edge of the Voronoi cells (rook weight matrix).

There are several reasons this weight matrix is particularly suitable to this study. First, this weight matrix avoids singularity issues since there are no islands, that is, schools without neighbors (minimum number of neighbors two, maximum number of neighbors ten, and average number of neighbors six). Second, this minimizes the sparseness of the contiguity matrix reducing the risk of biased estimates (density equal to 0.005; Kelejian and Prucha, 1998). Third, the edges of the Voronoi cell represent the shortest path to a school and mimic the boundaries of the attendance area (Mumm, 2004). Given the limited student transfers in Georgia (Governor's Office of Student Achievement, 2014), socio-economic characteristics of a school will be similar to those in its attendance area and this should better catch potential spillover effects.

Spatially lagged racial diversity indices with one and two lags were employed as instruments (Kelejian and Prucha, 1998; Monchuk et al., 2011). The racial fractionalization index defined at the district level in the 2010-2011 school year was also used for this purpose (Georgia Department of Education, 2010). Bootstrapped standard errors are estimated for all models. The bootstrapping methodology is the paired bootstrapping from Monchuk et al. (2011).

6. RESULTS

The Akaike information criterion (AIC) and the Lagrange Multiplier (LM) test for the baseline model are reported at the bottom of Table 3. The estimates of the SLX model are reported in Appendix Table 4 with the relative AIC. The comparison of the AICs and the LM test indicate that the SDEM shows a better fit than the SLX model. Note that this happens when either mathematics or reading is used as the dependent variable.

The endogeneity tests of the racial fractionalization index for this model are shown in Appendix Table 3. The test never rejects the null hypothesis of exogeneity. It is possible that the tests are not able to detect the presence of endogeneity, but this does not seem to be the case for Georgia public schools. First, although it is not possible to test if low-performing schools discourage high achieving racial groups from attending, student disengagement usually interests middle grades and increases in high school and college, but its incidence is more limited in elementary schools (Balfanz, Herzog, and Iver, 2007). Second, in Georgia, school transfers are

Table 3: SDEM MLE Results – Fourth Grade Mathematics and Reading Achievement Scores in Georgia Public Schools. School Year 2011-2012, Baseline Model

Dependent Variable (%)	Mathematics Score		Reading Score	
Independent Variable	Coefficient	Standard Error[1]	Coefficient	Standard Error[1]
Poverty Rate (% NSLP)	**-0.30*** **	0.02	**-0.19*** **	0.01
Student Teacher Ratio	**-0.42***	0.23	**-0.29** **	0.14
Teaching Experience	0.21	0.15	0.16	0.10
Per Pupil Spending ($1,000 real)	**0.48***	0.27	0.21	0.21
Racial Fract. Index (%)	**0.08*** **	0.02	**0.06*** **	0.01
Unemployment Rate (%)	0.07	0.10	0.02	0.07
Limited English (%)	**-0.15** **	0.07	0.04	0.05
Single Parent Families (%)	**-0.14*** **	0.02	**-0.07*** **	0.01
Pop. with High School Degree (%)	0.04	0.05	**0.04** **	0.02
Lag. Poverty Rate (% NSLP)	**0.04** **	0.02	**0.03** **	0.01
Lag. Student Teacher Ratio	0.15	0.52	0.03	0.28
Lag. Teaching Experience	**0.54***	0.30	0.06	0.23
Lag. Per Pupil Spending ($1,000 real)	**0.83** **	0.38	-0.13	0.26
Lag. Racial Fract. Index (%)	**0.08*** **	0.03	**0.03***	0.02
Lag. Unemployment Rate (%)	-0.12	0.22	-0.16	0.12
Lag. Limited English (%)	**-0.53*** **	0.15	-0.12	0.10
Lag. Single Parent Families (%)	**-0.19*** **	0.05	**-0.10*** **	0.03
Lag. Pop. With High School Degree (%)	**0.16** **	0.08	**0.13** **	0.05
Constant	**82.77*** **	12.76	**92.99*** **	7.82
Lambda	**0.32*** **	0.05	**0.25*** **	0.05
Log Likelihood Function	-3449		-3010	
AIC SDEM model	6937		6060	
R^2	0.65		0.61	
AIC SLX Model	6979		6085	
LM test H_0: $\lambda = 0$ in SDEM[2]	48 (0.00)		27 (0.00)	
Robust LM test H_0: $\lambda = 0$ in SDEM[3]	35 (0.00)		20 (0.00)	

Notes: [1] Paired bootstrapped standard errors as in Monchuk, Hayes, Miranowski, and Lambert (2011), 1000 replications.
[2] Anselin and Bera, (1998).
[3] Born and Beritung, (2011).
The symbols *, **, and *** represent significance at the 10 percent, 5 percent, and 1 percent, respectively. All the percent variables are multiplied by 100.

mobility, especially for low-income families, African-American households, and families with disabilities (Governor's Office of Student Achievement, 2014). For this group, it is plausible that mobility patterns are driven by other economic factors in addition to educational options allowed under the condition that they do not affect the racial composition of the school (Education

Commission of the States, 2015). In other words, if student mobility was due to school transfer, then this should not affect the racial composition. Third, student mobility may be tied to household (Coulton, Theodos, and Turner, 2012; Skobba and Goetz, 2013). Consequently, the maximum likelihood estimates for the SDEM are listed in Tables 3-6.

Table 3 shows the estimates for the baseline model. The direct effect of the racial fractionalization index on the achievement is positive and significant. This corresponds to 0.08 and 0.06 in mathematics and reading, respectively. The indirect effect is also positive and significant: 0.08 in mathematics (significant at the 1 percent level) and 0.03 in reading (significant at the 10 percent level). These results confirm the positive relationship between racial diversity and school performance and, moreover, find evidence of local spillover effects.

Direct and indirect effects are higher in mathematics than reading as noted in Tables 3-6. This seems to be due to the fact that the achievement gap is more pronounced in mathematics than reading in Georgia's fourth grade schools. In the study period, the difference in achievement scores in white and Asian majority schools, the two highest-performing racial groups, and all the other schools is 0.07 and 0.12 in reading and mathematics, respectively.[5]

Table 4 shows the estimates of the extended model. In urban schools, the direct effect of the racial fractionalization index on the achievement score is positive and significant. This corresponds to 0.17 and 0.10 in mathematics and reading, respectively. In suburban, town, and rural schools, the effect is reduced, but still positive.

In contrast, the lagged racial fractionalization index coefficient for urban schools is not different from zero in mathematics and reading as shown in Table 4. Note that this simplifies the analysis of the other lag coefficients since they can be interpreted as indirect effects and not just differences from urban schools. The strongest indirect effects are detected in suburban schools. This corresponds to 0.16 and 0.09 in mathematics and reading, respectively. The indirect effect is also consistent in town schools: 0.14 in mathematics and 0.07 in reading. Finally, positive indirect effects are present in rural schools, but their magnitude is limited as reported in Table 4.

Table 5 summarizes total, direct, and indirect effects of the racial fractionalization index from Tables 3 and 4. The total effect is the sum of direct and indirect effects (LeSage, 2014). Since the estimated coefficients represent slope shifters with respect to urban schools, the reported effect is equal to the specific coefficient plus the urban school coefficient. Globally, the largest total effect is observed in town schools. In these schools, direct and indirect effects are substantial. Suburban schools also show large total effects, mainly due to local spillovers. In contrast, urban schools have large direct effects, but no indirect effects.

Finally, the smallest total effect of the racial fractionalization index is observed in rural schools. This pattern is basically the same for mathematics and reading. In other words, it is not related to the subject, but rather quite general in nature. Note also that although the largest proportion of suburban schools is located in the Atlanta Metropolitan Area, as shown by Figure 2, almost no town schools are located in this region. In other words, the presence of local spillover effects of racial diversity impacts all of the non-urban schools in Georgia.

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[5] White and Asian students perform higher, on average, than other racial groups in Georgia and at the national level (The Nation's Report Card, 2013).

Table 4: SDEM MLE Results – Fourth Grade Mathematics and Reading Achievement Scores in Georgia Public Schools. School Year 2011-2012, Extended Model

Dependent Variable (%)	Mathematics Score		Reading Score	
Independent Variable	Coefficient	Standard Error[1]	Coefficient	Standard Error[1]
Poverty Rate (% NSLP)	**-0.29*** **	0.02	**-0.19*** **	0.01
Student Teacher Ratio	**-0.43***	0.22	**-0.29** **	0.14
Teaching Experience	0.11	0.15	0.12	0.09
Per Pupil Spending ($1,000 real)	**0.46***	0.26	0.22	0.19
Racial Fract. Index	**0.17*** **	0.03	**0.10*** **	0.02
Racial Fract. Index*Suburban	**-0.12*** **	0.03	**-0.05** **	0.02
Racial Fract. Index*Town	**-0.05***	0.03	**-0.02***	0.01
Racial Fract. Index*Rural	**-0.12*** **	0.04	**-0.06*** **	0.02
Unemployment Rate (%)	-0.01	0.11	-0.03	0.07
Limited English (%)	-0.11	0.10	0.02	0.04
Single Parent Families (%)	**-0.11*** **	0.02	**-0.06*** **	0.01
Pop. With High School Degree (%)	0.02	0.05	0.03	0.03
Lag. Poverty Rate (% NSLP)	0.04	0.03	**0.03** **	0.01
Lag. Student Teacher Ratio	0.25	0.46	0.14	0.26
Lag. Teaching Experience	0.31	0.28	0.09	0.20
Lag. Per Pupil Spending ($1,000 real)	**1.23*** **	0.40	0.09	0.31
Lag. Racial Fract. Index	-0.01	0.04	-0.02	0.04
Lag. Racial Fract. Index*Suburban	**0.16*** **	0.04	**0.09*** **	0.02
Lag. Racial Fract. Index*Town	**0.14*** **	0.05	**0.07** **	0.03
Lag. Racial Fract. Index*Rural	**0.07***	0.05	**0.06** **	0.03
Lag. Unemployment Rate (%)	-0.12	0.23	**-0.24***	0.15
Lag. No English (%)	**-0.57*** **	0.17	**-0.20***	0.11
Lag. Single Parent Families (%)	**-0.12** **	0.04	**-0.05***	0.03
Lag. Pop. With High School Degree (%)	**0.21** **	0.10	**0.15** **	0.06
Suburban (= 1 if school in suburb)	**7.31*** **	1.98	**3.12*** **	1.19
Town (= 1 if school in a town)	4.26	4.15	1.16	2.64
Rural (= 1 if school in rural area)	**7.57*** **	2.23	**3.89*** **	1.29
Constant	**78.85*** **	13.08	**88.92*** **	8.10
Lambda	**0.29*** **	0.05	**0.22*** **	0.05
Log Likelihood Function	-3427		-2995	
AIC SDEM Model	6,912		6,048	
R^2	0.68		0.64	
AIC SLX Model	6,944		6,067	

[1] Paired bootstrapped standard errors as in Monchuk, Hayes, Miranowski, and Lambert (2011), 1,000 replications.
The symbols *, **, and *** represent significance at the 10 percent, 5 percent, and 1 percent, respectively. All percent variables are multiplied by 100.

Table 5. Direct and Indirect Effect of the Racial Fractionalization Index on the Achievement Score[1]

	Mathematics Score		
School Location	Direct	Indirect	Total
Urban	0.17	0.00	0.17
Suburban	0.05	0.16	0.21
Town	0.12	0.14	0.26
Rural	0.04	0.07	0.12
Total	0.08	0.08	0.16
	Reading Score		
School Location	Direct	Indirect	Total
Urban	0.10	0.00	0.10
Suburban	0.05	0.09	0.14
Town	0.08	0.07	0.15
Rural	0.04	0.06	0.10
Total	0.06	0.03	0.09

[1] Estimated coefficients from Table 3 and Table 4. A statistically insignificant coefficient is reported as zero.

These results suggest that the direct and indirect effects could decrease and increase, respectively, with respect to the magnitude of racial diversity. For low levels of racial diversity, the largest direct effects are observed in urban schools. In contrast, for high levels of racial diversity, the largest indirect effects are observed in suburban and town schools. The estimates with slope shifters defined over the quartiles of the racial fractionalization index are reported in Table 6. The largest direct effect is observed for the first quartile of the racial fractionalization index. This corresponds to 0.19 and 0.23 in mathematics and reading, respectively. It is interesting to note that only the coefficient of the second quartile in the reading equation is statistically significant, but with a smaller magnitude than the first quartile.

In contrast, the indirect effects are positive and significant only for the fourth quartile: 0.09 in mathematics and 0.04 in reading. In addition, the slope shifter of the first quartile is negative and, moreover, larger than the estimates of the fourth quartile. This implies that the first quartile has a negative indirect effect (-0.04 = 0.09 – 0.13 in mathematics, similarly in reading). In conclusion, these results indicate that direct effects are stronger for low levels of racial diversity (urban schools) while indirect effects predominate at the higher levels of racial fractionalization (suburban and town schools).

7. CONCLUSIONS

This paper finds evidence of a positive relationship between racial diversity and achievement score for the fourth grade students in the Georgia public schools. Direct effects are stronger for low levels of racial diversity, that is, urban schools. This might confirm the nonlinearity of racial peer effects, namely that lower achieving students gain more from peer effects than higher achieving students (Summers and Wolfe, 1977; Hoxby, 2000; McEwan, 2003). In contrast, indirect effects are stronger for high levels of racial diversity, that is, suburban and town schools.

Table 6: SDEM MLE Results – Fourth Grade Mathematics and Reading Achievement Scores in Georgia Public Schools. School Year 2011-2012, Extended Model

Dependent Variable (%)	Mathematics Score		Reading Score	
Independent Variable	Coefficient	Std Error[1]	Coefficient	Std Error[1]
Poverty Rate (percent NSLP)	**-0.30*** **	0.02	**-0.19*** **	0.01
Student Teacher Ratio	**-0.41* **	0.22	**-0.29** **	0.14
Teaching Experience	0.19	0.16	0.14	0.09
Per Pupil Spending ($1,000 real)	0.48	0.32	0.23	0.19
Racial Fract. Index	0.11	0.12	0.06	0.07
Racial Fract. Index*1th Quartile	**0.19* **	0.10	**0.23*** **	0.08
Racial Fract. Index*2nd Quartile	0.01	0.15	**0.09* **	0.05
Racial Fract. Index*3rd Quartile	0.17	0.22	0.08	0.12
Unemployment Rate (%)	-0.03	0.10	-0.04	0.07
Limited English (%)	-0.13	0.08	0.02	0.05
Single Parent Families (%)	**-0.13*** **	0.02	**-0.06*** **	0.01
Pop. With High School Degree (%)	0.04	0.06	0.04	0.03
Lag. Poverty Rate (% NSLP)	0.05	0.05	**0.03** **	0.01
Lag. Student Teacher Ratio	0.18	0.50	0.08	0.23
Lag. Teaching Experience	0.46	0.38	0.07	0.18
Lag. Per Pupil Spending ($1,000 real)	**0.81** **	0.41	0.16	0.25
Lag. Racial Fract. Index	**0.09** **	0.04	**0.04* **	0.02
Lag. Racial Fract. Index*1th Quartile	**-0.13*** **	0.03	**-0.08*** **	0.02
Lag. Racial Fract. Index*2nd Quartile	-0.02	0.04	-0.01	0.03
Lag. Racial Fract. Index*3rd Quartile	-0.02	0.03	-0.01	0.02
Lag. Unemployment Rate (%)	-0.10	0.23	-0.18	0.14
Lag. No English at Home (%)	**-0.54*** **	0.16	-0.13	0.09
Lag. Single Parent Families (%)	**-0.18*** **	0.04	**-0.08*** **	0.03
Lag. Pop. with High School Degree (%)	**0.17** **	0.08	**0.13** **	0.05
1st Quartile (= 1 if racial frac index <25th percentile)	-1.16	9.78	-3.31	5.49
2nd Quartile (= 1 if racial frac index > 25th and < 50th percentiles)	0.49	10.77	-0.56	5.88
3rd Quartile (= 1 if racial frac index ≥50th and < 75th percentiles)	-11.26	15.39	**-20.98** **	8.27
Constant	**88.70*** **	17.17	**92.86*** **	9.43
Lambda	**0.33*** **	0.05	**0.25*** **	0.05
Log Likelihood Function	-3,441		-2,986	
AIC SDEM Model	6,940		6,029	
R^2	0.66		0.62	
AIC SLX Model	6,983		6,053	

[1] Paired bootstrapped standard errors as in Monchuk, Hayes, Miranowski, and Lambert, (2011), 1000 replications.
The symbols *, **, and *** represent significance at the 10 percent, 5 percent, and 1 percent, respectively. All the % variables are multiplied by 100.

Traditional educational policies to foster racial integration are addressed to reduce the achievement gap where it is more likely to be present, that is, in urban schools (Armor, 1995). Although direct effects are stronger in these schools, this study suggests that this may not be the case due to the lack of indirect effects. If racial integration represents a winning strategy to stimulate the achievement score, this study suggests that it should be implemented where the total effect is stronger, that is, in suburban and town schools. Due to the substantial spillover effects present in these schools, this may have a positive influence in the neighbor schools. In addition, the community composition is already differentiated in these schools and this suggests limited counterproductive effects in terms of social and housing market issues (Hall and Leeson, 2010b; Lareau and Goyette, 2014; Toppo and Overberg, 2014). Finally, although it sounds counterintuitive, increasing racial diversity where it is already present can represent a starting point to gradually move towards inner city schools.

Future research should extend de Bartolome's model to more communities with fixed and differentiated levels of taxations. This would allow researchers to jointly analyze inter- and intra-district student mobility effects. Moreover, theoretical and empirical analysis should consider how the level of racial diversity affects student mobility.

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APPENDIX

Appendix Table 1: Variable Definitions and Sources

Variable Name	Description	Source
Mathematics	Share of fourth grade students who met or exceed the standard of the Criterion Reference Competence Test (CRCT) in mathematics, 2011-2012.	Georgia Department of Education
Reading	Share of fourth grade students who met or exceed the standard of the CRCT in reading, 2011-2012.	Georgia Department of Education
Poverty Rate	Share of fourth grade students eligible to participate in the free or reduced-price lunch program under the National School Lunch Act.	National Center for Education Statistics
Student/teacher Ratio	Full-time equivalent students divided by full-time equivalent teachers.	The Governor's Office of Student Achievement
Experience	Average years of experience of PK-12 teachers.	The Governor's Office of Student Achievement
Per Pupil Spending	Annual spending per full-time equivalent student[1].	Georgia Department of Education
African-American percent	Fourth grade African-American student share.	National Center for Education Statistics
Asian percent	Fourth grade Asian student share.	National Center for Education Statistics
Hispanic percent	Fourth grade Hispanic student share.	National Center for Education Statistics
White percent	Fourth grade White student share.	National Center for Education Statistics
Other percent	Fourth grade American-Indian/Alaska native, Hawaiian Native /Pacific Islander, and two or more races share.	National Center for Education Statistics
Limited English Speaking Household percent	Household share of no one age 14 and over speaks English "very well".	U.S. Census Bureau, 2009-2013 5-Year American Community Survey[2]
Unemployment Rate	2008-2012 unemployment rate.	U.S. Census Bureau, 2009-2013 5-Year American Community Survey[2]

Appendix Table 1. Continued

Variable Name	Description	Source
Single Parent Families Share	2008-2012 single parent families divided total families.	U.S. Census Bureau, 2009-2013 5-Year American Community Survey[2]
Population with High School Degree or Higher percent	2008-2012 share of population with high school degree or more, 25 years and older.	U.S. Census Bureau, 2009-2013 5-Year American Community Survey[2]
Urban	= 1 if the school is located inside urban area and inside the principal city, 0 otherwise.	National Center for Education Statistics
Suburban	= 1 if the school is located in an urban area, but outside the principal city, 0 otherwise.	National Center for Education Statistics
Town	= 1 if the school is located in a town, 0 otherwise.	National Center for Education Statistics
Rural	= 1 if the school is located in a rural area, 0 otherwise.	National Center for Education Statistics

Notes: [1] Adjusted with the Consumer Price index of the Atlanta-Georgia area, 2011 base year (Bureau of Labor Statistics, 2015).
[2] Census tract level, year 2011.

Appendix Table 2: Variable Definitions and Sources of the School Location Variables[1]

Urban	City, Large: Territory inside an urbanized area and inside a principal city with population of 250,000 or more. City, Midsize: Territory inside an urbanized area and inside a principal city with population less than 250,000 and greater than or equal to 100,000. City, Small: Territory inside an urbanized area and inside a principal city with population less than 100,000.
Suburban	Suburb, Large: Territory outside a principal city and inside an urbanized area with population of 250,000 or more. Suburb, Midsize: Territory outside a principal city and inside an urbanized area with population less than 250,000 and greater than or equal to 100,000. Suburb, Small: Territory outside a principal city and inside an urbanized area with population of at least 50,000 and less than 100,000.
Town	Town, Fringe: Territory inside an urban cluster that is less than or equal to 10 miles from an urbanized area. Town, Distant: Territory inside an urban cluster that is more than 10 miles and less than or equal to 35 miles from an urbanized area. Town, Remote: Territory inside an urban cluster that is more than 35 miles from an urbanized area.
Rural	Rural, Fringe: Census-defined rural territory that is less than or equal to 5 miles from an urbanized area, as well as rural territory that is less than or equal to 2.5 miles from an urban cluster. Rural, Distant: Census-defined rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area, as well as rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster. Rural, Remote: Census-defined rural territory that is more than 25 miles.

[1] Source: National Center for Education Statistics (2015). The urban and rural classification is from US Census Bureau 2010 and falls into three categories: Urbanized Areas (UAs) of 50,000 or more people (city and suburbs); Urban Clusters (UCs) of at least 2,500 and less than 50,000 people (town); Rural areas encompass all population, housing, and territory not included within an urbanized area and urban cluster.

Appendix Table 3: Endogeneity Test of the Racial Fractionalization Index in the SDEM Baseline Model[1]

Instrument	Math[2]	Reading[2]
1st Spatial Lag of the Racial Fractionalization Index in 2011-12	0.04	0.17
	(0.97)	(0.87)
2nd Spatial Lag of the Racial Fractionalization Index in 2011-12	0.34	0.50
	(0.73)	(0.62)
Racial Fractionalization Index in 2010-11[3]	1.03	0.44
	(0.30)	(0.66)
1st Spatial Lag, 2nd Spatial Lag, and Racial Fractionalization Index in 2010-11[3]	0.81	0.69
	(0.42)	(0.49)

Notes: [1] p-values in parenthesis.
[2] Significance with respect to the bootstrapped standard errors.
[3] School district level, Georgia Department of Education (2010).

Appendix Table 4: SLX MLE Results – Fourth Grade Mathematics and Reading Achievement Scores in Georgia Public Schools. School Year 2011-2012, Baseline Model

Dependent Variable (%)	Mathematics Score		Reading Score	
Independent Variable	Coefficient	Std Error[1]	Coefficient	Std Error[1]
Poverty Rate (% NSLP)	**-0.30*** **	0.03	**-0.19*** **	0.02
Student Teacher Ratio	**-0.41***	0.24	**-0.30***	0.18
Teaching Experience	0.21	0.21	0.17	0.13
Per Pupil Spending ($1,000 real)	0.47	0.34	0.18	0.21
Racial Fract. Index (%)	**0.08*** **	0.03	**0.06*** **	0.02
Unemployment Rate (%)	0.07	0.14	0.02	0.07
Limited English (%)	-0.15	0.09	0.04	0.06
Single Parent Families (%)	**-0.14*** **	0.04	**-0.07*** **	0.02
Pop. With High School Degree (%)	0.05	0.08	0.04	0.05
Lag. Poverty Rate (percent NSLP)	**0.04***	0.03	0.03	0.02
Lag. Student Teacher Ratio	0.04	0.45	0.03	0.21
Lag. Teaching Experience	**0.56** **	0.29	-0.02	0.17
Lag. Per Pupil Spending ($1,000 real)	**0.84** **	0.43	-0.07	0.28
Lag. Racial Fract. Index (%)	**0.09*** **	0.02	**0.03***	0.02
Lag Unemployment Rate (%)	-0.15	0.26	-0.10	0.11
Lag. Limited English (%)	**-0.49*** **	0.18	-0.11	0.08
Lag. Single Parent Families (%)	**-0.23*** **	0.07	**-0.12*** **	0.03
Lag. Pop. with High School Degree (%)	**0.15***	0.08	**0.12** **	0.04
Constant	**83.75*** **	16.70	**93.42*** **	6.51
Log Likelihood Function	-3,470		-3,022	
AIC SLX Model	6,979		6,085	
R^2	0.64		0.61	

Notes: [1] Robust Standard Error.
The symbols *, **, and *** represent significance at the 10 percent, 5 percent, and 1 percent, respectively. All the percent variables are multiplied by 100.